2012 SAE Power Systems Conference
October 30 - November 1, 2012 - Phoenix, Arizona, USA

Simulation and validation of energy and thermal management of an electrically-powered UAV

Y. Lemmens[3*], J. Verbeke[1], R. De Roo[2], I. Becuwe[2], T. Olbrechts[3]

[1] KUL, Faculty of Engineering Technology, W. de Croylaan 6, 3001 Heverlee, Belgium
[2] KHBO Aerospace, Nieuwpoortsesteenweg 945c, 8400 Oostende, Belgium
[3] LMS International, Aerospace Competence Centre, Interleuvenlaan 68, 3000 Leuven, Belgium
*Contact person: yves.lemmens@lmsintl.com

This paper reports on the work that has been performed in the context of a 2-year research program about the development of a new UAV platform at the aerospace engineering department of the KHBO in Belgium. The UAV platform is aimed at performing scientific missions along the Belgian coast line above the North Sea. The main performance requirement of the UAV is a range of 160km with at payload of 5kg. A propulsion system of two electrical brushless DC motors has been selected in order to minimize the environmental impact during operation by avoiding gas emissions and reducing noise emissions. Test flights of the UAV prototype are planned in June 2012.

Since the UAV is completely electrically powered, the analysis of the energy management of the integrated electrical system and its thermal effects are critical to the development of the UAV. Therefore LMS International is involved in the project to support the electro-thermal analysis of the aircraft with its multi-physics system simulation software LMS Imagine.Lab AMESim.

First, the electrical system that will be used during the test flights was completely modeled. This included models of the energetic behavior of all electrical components. Also the input control signals were modeled and are used to control the behavior of the electrical system. The objective of the electrical system model is to support the sizing of the components and batteries to achieve the required performance.

The energetic behavior of all components was validated on test benches. This included a test bench of the motor with propeller were also the propeller torque and thrust were measured, together with the power consumption of the motor and its electronic speed control (ESC). As a result, a validated electrical system model was obtained.

Subsequently, the electrical system model was extended with thermal behavior of all components inside the fuselage. The main heat-producing components are the batteries and the ESC. The objective of the electro-thermal model was to identify if additional ventilation of the fuselage is needed or dedicated cooling of some components, such as the ESC, is needed. This will result in the selection of the optimal configuration.